TM 11-1233

WAR DEPARTMENT TECHNICAL MANUAL

SIGNAL GENERATOR TS-343/U

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WAR DEPARTMENT *24 FEBRUARY 1945*

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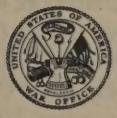

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WAR DEPARTMENT,
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TM 11-1233, Signal Generator TS-343/U, is published for the information and guidance of all concerned.

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(For explanation of symbols see FM 21-6.)

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DESTRUCTION NOTICE

WHY —To prevent the enemy from using or salvaging this equipment for his benefit.

WHEN—When ordered by your commander.

HOW —1. Smash—Use sledges, axes, handaxes, pickaxes, hammers, crowbars, heavy tools.

2. Cut—Use axes, handaxes, machetes.

3. Burn—Use gasoline, kerosene, oil, flame throwers, incendiary grenades.

4. Explosives—Use firearms, grenades, TNT.

5. Disposal—Bury in slit trenches, fox holes, etc. Throw in streams. Scatter.

USE ANYTHING IMMEDIATELY AVAILABLE FOR DESTRUCTION OF THIS EQUIPMENT.

WHAT—1. Smash—Meter, controls, attenuator, tubes, r-f oscillator section, coils, and other components.

2. Cut—As many wires and leads as time permits.

3. Burn—Technical manuals, schematic diagrams, insulation on wiring, coil forms, and all inflammable parts.

4. Bend—Dial scale and drum and front panel.

5. Bury or scatter—All of the above pieces after destroying their usefulness.

DESTROY EVERYTHING

WARNING

HIGH VOLTAGE

is used in the operation
of the radio equipment.

DEATH ON CONTACT

may result if personnel fail
to observe safety precautions.

Be careful to avoid contact with high-voltage circuits or 115-volt a-c input connections while checking or servicing radio equipment. Make certain that the power is turned off before disassembling any part of the radio equipment.

Dangerously high voltages are present in the power supplies of the radio equipment. Before making any service checks, manually discharge all high-voltage capacitors in these circuits after the a-c power has been removed from the components.

FIRST AID TREATMENT FOR ELECTRIC SHOCK

I. FREE THE VICTIM FROM THE CIRCUIT IMMEDIATELY.

Shut off the current. If this is not immediately possible, use a dry nonconductor (rubber gloves, rope, board) to move either the victim or the wire. Avoid contact with the victim. If necessary to cut a live wire, use an axe with a dry wooden handle. Beware of the resulting flash.

II. ATTEND INSTANTLY TO THE VICTIM'S BREATHING.

Begin resuscitation at once on the spot. Do not stop to loosen the victim's clothing. Every moment counts. Keep the patient warm. Wrap him in any covering available. Send for a doctor. Remove false teeth or other obstructions from the victim's mouth.

Resuscitation

POSITION

1. Lay the victim on his belly, one arm extended directly overhead, the other arm bent at the elbow, the face turned outward and resting on hand or forearm so that the nose and mouth are free for breathing (fig. A).
2. Straddle the patient's thighs, or one leg, with your knees placed far enough from his hip bones to allow you to assume the position shown in figure A.
3. Place your hands, with thumbs and fingers in a natural position, so that your palms are on the small of his back, and your little fingers just touch his lowest ribs (fig. A).

FIRST MOVEMENT

4. With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the victim. Your shoulders should be directly over the heels of your hands at the end of the forward swing (fig. B). Do not bend your elbows. The first movement should take about 2 seconds.

SECOND MOVEMENT

5. Now immediately swing backward, to remove the pressure completely (fig. C).
6. After 2 seconds, swing forward again. Repeat this pressure-and-release cycle 12 to 15 times a minute. A complete cycle should require 4 or 5 seconds.

CONTINUED TREATMENT

7. Continue treatment until breathing is restored or until there is no hope of the victim's recovery. Do not give up easily. Remember that at times the process must be kept up for hours.
8. During artificial respiration, have someone loosen the victim's clothing. Wrap the victim warmly; apply hot bricks, stones, etc. Do not give the victim liquids until he is fully conscious. If the victim must be moved, keep up treatment while he is being moved.
9. At the first sign of breathing, withhold artificial respiration. If natural breathing does not continue, immediately resume artificial respiration.
10. If operators must be changed, the relief operator kneels behind the person giving artificial respiration. The relief takes the operator's place as the original operator releases the pressure.
11. Do not allow the revived patient to sit or stand. Keep him quiet. Give hot coffee or tea, or other internal stimulants.

HOLD RESUSCITATION DRILLS REGULARLY

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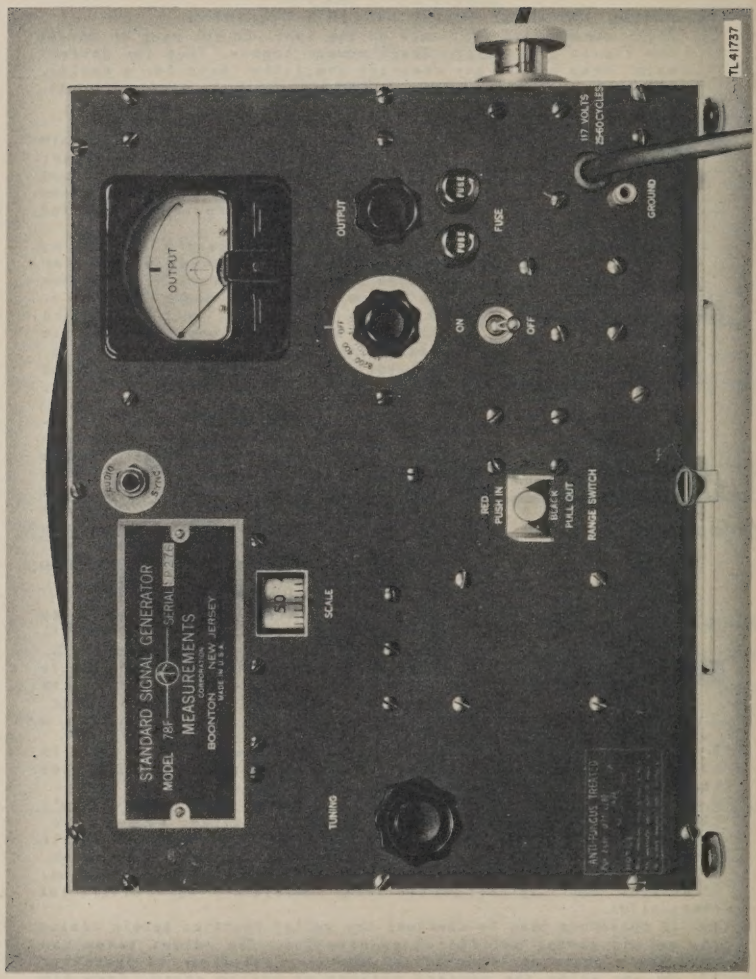

Figure 1. Signal Generator TS-343/U.

PART ONE

INTRODUCTION

SECTION I

DESCRIPTION

1. GENERAL.

Signal Generator TS-343/U (fig. 1) is a precision instrument designed to provide a source of continuous-wave, radio-frequency (r-f) oscillations in two frequency ranges. These r-f oscillations can be modulated as required with either 400 or 8,200 cycles by means of a rotary switch (fig. 2) on the front panel. When not required, the modulation can be turned off. The instrument, which is self-contained and portable, can be operated from any 115/120-volt, 25/60-cycle, a-c power source.

2. APPLICATION.

The principal use of the signal generator is for the alignment of radio receivers. The instrument can also be used to provide a signal, when used in conjunction with a suitable output indicator, in trouble shooting a defective receiver.

3. TECHNICAL CHARACTERISTICS.

a. This instrument generates r-f signals in two ranges; namely, 15 to 28 megacyles, and 27 to 50 megacycles. Either of these ranges can be selected by means of the range switch (fig. 2) located in the middle lower section of the instrument panel. The low range is selected by pushing the switch all the way in, and the high range is selected by pulling the switch out.

b. The output of the signal generator can be either modulated or unmodulated. The MODULATION switch (fig. 2), located below the output meter, is used to turn the modulation *on* or *off*,

and to select either 400- or 8,200-cycle modulation. The percentage of modulation is fixed at approximately 30 percent.

c. The OUTPUT control (fig. 2), located directly beneath the output meter, is used to adjust the pointer on the meter. The output voltage is continuously variable from 1 microvolt to 100,000 microvolts by adjustment of the output coupling loop. This is accomplished by means of the sliding attenuator control tube on the right side of the instrument. Attached to this control are the output cable and output terminals (fig. 2). The amount of output is indicated on a scale engraved on the sliding tube. When the tube is all the way out, the coupling is at a minimum and the output voltage is 1 microvolt. When the tube is all the way in, the coupling is at a maximum and the output voltage is 100,000 microvolts. The output impedance is fixed at 17 ohms.

d. The correct dial setting for the frequency desired is chosen from the frequency calibration chart (fig. 2) located on the bottom of the instrument. This chart is pulled out drawer-wise for use. The low range is designated in *red* on the chart and the chart reading is extended to the red line. The high range is designated in *black* and the chart reading is extended to the black line. The tuning control is located on the extreme left section of the instrument panel.

e. In addition to the above-mentioned controls, an ON-OFF power switch, two fuses, and a GROUND post are located beneath the meter on the right section of the instrument panel (fig. 2).

f. The tubes used in the instrument are as follows:

(1) One type 9002 r-f oscillator tube.

(2) One type 7Y4 rectifier tube.

(3) One type VR-150/30 voltage regulator tube.

(4) One type 7L7 amplifier tube.

(5) One type 7C5 modulator tube.

g. The instrument dimensions are 13 inches wide, 10 inches high, and 7 inches deep. The weight of the unit is approximately 25 pounds.

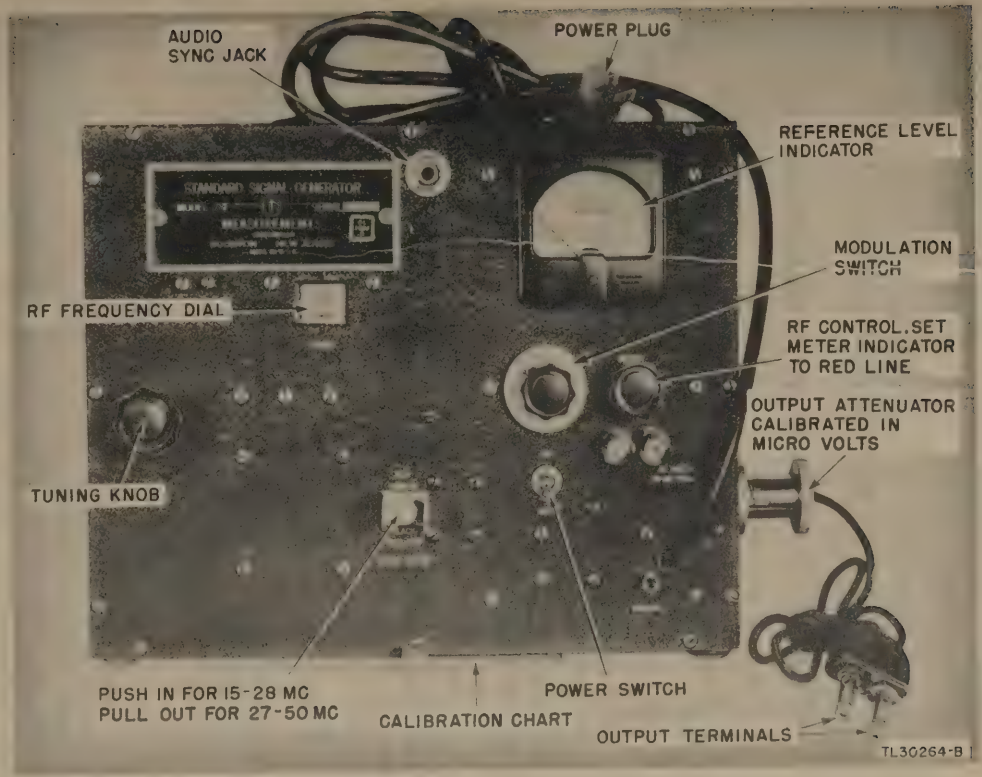

Figure 2. Signal Generator TS-243/U, front view.

SECTION II

INSTALLATION AND ASSEMBLY

4. UNPACKING.

Use particular care when unpacking or handling the instrument, since it is easily damaged. In unpacking the test set follow the steps outlined below.

a. Place the packing case in a convenient location.

b. Cut the steel straps.

c. Remove the nails with a nail puller, and remove the top of the packing case. *Do not pry the top off, or the instrument may be damaged.*

d. Carefully lift the test set from the packing case and remove the covering.

e. Inspect the instrument thoroughly for possible damage during shipment.

f. Check the components against the master packing slip.

g. Make sure that the vacuum tubes are seated properly in the correct sockets.

h. If a set of spare tubes is stored in the case, remove them and place them in stock.

CAUTION: If the chassis has received moistureproofing and fungiproofing treatment, *do not remove* any of the protective coating.

5. INSTALLATION.

Place the signal generator in a convenient spot on the workbench, along with the equipment to be serviced and any auxiliary test equipment that may be needed. Connect a ground wire from the ground terminal on the signal generator to the chassis of the radio receiver and to the chassis of any associated equipment. *Ground this wire securely.*

PART TWO

OPERATING INSTRUCTIONS

SECTION III

PREOPERATIONAL PROCEDURES

6. PREPARATION FOR USE.

After the signal generator has been installed on the workbench, prepare the instrument for use as outlined below.

a. Plug the power cord into a 115/120-volt a-c line having a frequency of 25/60 cycles.

b. Throw the power switch (fig. 2) to the ON position. Allow at least 15 minutes for the instrument to reach proper operating temperature.

c. Adjust the pointer of the output meter to the red mark on the scale by means of the control marked OUTPUT. If no reading is obtained on the meter, see that the RANGE SWITCH is either all the way in or all the way out. Inspect the fuses beneath the output control knob. These fuses are removable from the front of the instrument by unscrewing them from their holders (fig. 2).

d. Select the desired frequency range by means of the two-position push-pull RANGE SWITCH (fig. 2) on the instrument panel.

e. By means of the tuning control located on the left section of the panel, adjust the frequency dial to the correct frequency as determined from the frequency calibration chart (fig. 2) mounted under the instrument. To obtain the correct frequency, refer to the example given below.

EXAMPLE: Assume that the desired range is 40 megacycles. Read down the left side of the chart until the 40 mark is reached. Then project across the chart to the intersection

of the curved black line. The figures at the bottom of the chart show the dial reading at the intersection point. This final reading is the designated scale division. If the low range is desired, follow the same procedure but project the range figure across to the intersection of the curved red line. Rotate the tuning control knob until the black hairline on the dial glass is directly over the designated scale division.

f. To secure a modulated output, turn the MODULATION dial to the 400 or 8,200 position. To remove the modulation, set the dial to OFF.

g. Insert the correct dummy antenna resistance in series with the output leads. This resistance is obtained by subtracting 17 from the desired value; for example, if the receiver operates from a 100-ohm cable, the dummy antenna resistance should be 100 minus 17, or 83 ohms. If the receiver is designed for operation from a balanced input line, this dummy antenna resistance should be half as much as the above value (41 ohms each for a 100-ohm input) inserted in each lead. *Short leads must be used to connect the output terminals of the signal generator to the receiver.*

h. Check the output meter to see that the pointer is adjusted to the red line; otherwise, the output voltage indicated on the engraved scale of the attenuator control tube will be incorrect.

i. Before applying the test leads to the circuit under test, connect a 0.006-mf blocking capacitor in series with the "hot" lead (the lead to which voltage is applied). There is no blocking capacitor in the output circuit of the signal generator; unless one is inserted, the secondary of the output transformer will provide a short-circuited path for any d-c potentials across which the test leads may be applied. This will result in possible damage to the instrument or, at least, inaccuracies in output reading.

SECTION IV

OPERATION

7. TEST PROCEDURES.

a. General. This section of the manual gives general instructions in the use of the signal generator for r-f alignment, i-f alignment, and trouble shooting in radio receivers. In the alignment and trouble-shooting procedures a receiver output indicator is used in conjunction with the signal generator. This is usually an output meter or a test oscilloscope, which is connected to the output of the receiver. The test procedures outlined below are general and do not apply to any specific receiver. In the application of the signal generator, a basic radio receiver is assumed, having two r-f stages, a mixer stage with separate oscillator and buffer stages, three i-f stages, a detector stage, and a video (or audio) output stage. When the application of the signal generator to this basic receiver is understood, no difficulty will be experienced in the servicing of more advanced or modified receiver circuits. In the procedures described below it is assumed that the signal generator has been prepared for use as outlined in paragraph 6.

CAUTION: Before attempting any tests, make sure that the blocking capacitor has been inserted in series with the *hot* test lead as indicated in paragraph 6i.

b. I-f Alignment. When the signal generator is used for i-f alignment, the procedure is as follows:

NOTE: To prevent interaction between the local oscillator of the receiver and the signal generator, the oscillator stage must be made inactive. This can be done either by shorting the plates of the oscillator tuning capacitor, disconnecting the lead to the mixer or to the klystron plate, or removing the tube from its socket.

(1) Throw the receiver power switch to the ON position. Allow at least 15 minutes for the receiver to reach proper operating temperature.

(2) Connect the output indicator to the receiver output jack. Be sure that the three units are grounded together (par. 5).

(3) Connect the test leads of the signal generator between the grid of the last i-f tube and ground. Use a modulated signal.

(4) Adjust the output attenuator control (fig. 2) to give an adequate indication on the output indicator.

(5) Using an alignment tool, adjust the trimmer capacitors on the primary and secondary of the final i-f transformer for maximum indication on the output indicator.

(6) Remove the signal generator lead from the grid of the last i-f tube and connect it to the grid of the next-to-last i-f tube.

(7) Adjust the trimmer capacitors on the primary and secondary of the next-to-last i-f transformer for maximum indication on the output indicator.

(8) Continue this process, working back from the detector stage until all of the i-f stages have been adjusted. The i-f transformer in the plate circuit of the mixer tube is aligned with the signal generator lead connected to the grid of the mixer tube. It is necessary to reduce the output of the signal generator as more of the i-f stages are brought into use in order to prevent overloading of the stages with consequent inaccuracies in the output readings. Use the minimum signal strength that will give adequate output indications.

c. R-f Alignment. When the frequency of the r-f stages of a receiver falls within the ranges covered by the signal generator, these stages can be aligned as described below. It is assumed that the receiver r-f stages are peaked to one specific frequency and that receiver tuning is accomplished by means of the oscillator tuning capacitor, as is the case in conventional radar systems. Alignment is then restricted to the oscillator buffer stage and the r-f stages. This is done as follows:

NOTE: If the oscillator stage has been rendered inoperative for purposes of i-f alignment, operation must be restored before making any attempts at r-f alignment.

(1) With power applied to the receiver under test and the output indicator connected to the receiver output jack, connect the test leads of the signal generator between the grid of the mixer tube (or the input to the mixer) and ground. Use the correct frequency with modulation.

(2) Adjust the attenuator control to give an adequate indication on the output indicator. Because of the high frequency to which it is tuned, the impedance of the mixer grid circuit may be sufficiently low to short-circuit the output of the signal gen-

erator. If this occurs, disconnect the grid circuit of the mixer tube. Tune the receiver oscillator to maximum.

(3) Using an alignment tool, adjust the trimmer capacitors in the oscillator-buffer stages for maximum indication on the output indicator. After the alignment is completed, reconnect the grid circuit of the mixer stage.

(4) Remove the signal generator lead from the mixer tube grid and connect it to the grid of the final r-f tube.

(5) Adjust the trimmer capacitors on the primary and secondary of the final r-f transformer for maximum indication on the output indicator.

(6) Continue this process, working back from the mixer stage until all of the r-f stages have been adjusted. Reduce the signal generator output in order to prevent overloading the stages with resulting inaccuracies in the output indication.

d. Trouble Shooting. This signal generator can be used effectively in trouble shooting a receiver using the signal-substitution method. In this method the signal from the signal generator is substituted for the normal signal introduced into the receiver. A modulated signal must be used in order to give an indication on the output indicator. This signal can then be applied to the input (or output) of any stage in order to isolate the defective circuit. With an output indicator connected to the output of the receiver, the usual practice is first to determine in which section of the receiver (audio, i-f, r-f, etc.) the defect is located. This is done by introducing the signal into the input stage of each section, beginning with the audio section and working back to the first r-f stage. After the defect has been localized to a particular section, each stage in this section is then tested beginning with the final stage and working back to the first stage until the defective stage is isolated. An analyzer is then used to isolate the defective part. This signal generator has no audio output; when trouble shooting the audio section, therefore, a modulated signal must be introduced into either the grid circuit or the plate circuit of the final i-f stage. Before applying this method of trouble shooting to a defective receiver, use the analyzer to determine whether or not the receiver power supply is operating normally.

PART THREE

PREVENTIVE MAINTENANCE

SECTION V

PREVENTIVE MAINTENANCE TECHNIQUES

8. MEANING OF PREVENTIVE MAINTENANCE.

Preventive maintenance is a systematic series of operations performed at regular intervals on the test equipment, when not in use, to prevent major break-downs and to keep the equipment operating at top efficiency. To understand what is meant by preventive maintenance, it is necessary to distinguish between preventive maintenance, trouble shooting, and repair. The primary function of preventive maintenance is to *prevent* break-downs and, therefore, the need for repair. On the other hand, the primary function of trouble shooting and repair is to locate and correct *existing* defects. The importance of preventive maintenance cannot be overemphasized. The entire system of communications depends upon the readiness and operating efficiency of each item of equipment when it is needed. Likewise the test equipment, by means of which this readiness and efficiency is maintained, must be kept in excellent operating condition at all times.

9. DESCRIPTION OF PREVENTIVE MAINTENANCE TECHNIQUES.

a. General.

(1) Most of the electrical parts used in the signal generator require routine preventive maintenance. Because hit-or-miss maintenance techniques cannot be applied, definite and specific instructions are needed. This section of the manual contains these specific instructions and serves as a guide for personnel assigned to perform the five basic maintenance operations (FITCA); namely, *Feel, Inspect, Tighten, Clean,* and *Adjust.* Throughout this manual the lettering system for the five operations will be as follows:

F—Feel.

I—Inspect.

T—Tighten.

C—Clean.

A—Adjust.

(2) The first two operations establish the need for the other three. The selection of operations is based upon a general knowledge of field conditions. For example, the dust encountered on dirt roads during cross-country travel filters into the equipment no matter how much care is taken to prevent it. Rapid changes in weather (such as heavy rain followed by blistering heat), excessive dampness, snow, and ice tend to cause corrosion of exposed surfaces and parts. Without frequent inspections and the necessary performance of tightening, cleaning, and adjusting operations, equipment becomes undependable and subject to break-down when it is most needed.

b. Feel. The *feel* operation on the signal generator is used to determine whether electrical connections, bushings, chokes, and transformers are overheated. This indicates a defect in the part or in associated parts in the circuit. The maintenance man must become familiar with the normal operating temperatures in order to recognize signs of overheating.

NOTE: It is important that the feel operation be performed as soon as possible after shut-down in order to check the parts before they become cool.

c. Inspect. Inspection is the most important operation in the preventive maintenance program. A careless observer will overlook the evidences of minor trouble. Although these defects may not interfere with the performance of the equipment, they must be corrected before they lead to major break-downs. Make every effort to become thoroughly familiar with the indications of normal functioning in order to recognize the signs of a defective set. Inspection consists of carefully observing all parts of the equipment, noticing any discoloration, state of cleanliness, position of wiring, etc. Inspect for the following conditions:

(1) Overheating, as indicated by discoloration, blistering, or bulging of the parts or surface of the container; leakage of insulating compounds; and oxidation of metal contact surfaces.

(2) Position of wiring; see that all leads and cabling are in their original positions.

(3) Cleanliness; carefully examine all recesses in the unit for accumulations of dust, especially between connecting terminals.

Parts, connections, and joints should be free of dust, corrosion, and other foreign matter. In tropical and high-humidity locations, look for fungus growth and mildew.

(4) Tightness; test any connection or mounting that appears to be loose.

d. Tighten. This operation consists of tightening all loose mounting screws, terminals, and connections.

CAUTION: Screws, bolts, and nuts should not be tightened carelessly. Fittings tightened beyond the pressure for which they are designed will be damaged or broken. Whenever a loose connection is tightened, it should be moistureproofed and fungiproofed again by applying the varnish with a small brush. See section VII for details of moistureproofing and fungiproofing.

e. Clean. The instrument must be kept thoroughly clean. All corrosion must be removed from metal parts and connections. Use crocus cloth, if necessary. Dust, dirt, and other foreign matter can be removed by using a clean cloth moistened with cleaning solvent. Use care when cleaning near the meter.

f. Adjust. The meter pointer should indicate zero on the meter scale when the signal generator is not in use. If necessary, adjust the meter to zero with a small screwdriver. Before deciding that a meter needs readjusting, tap the meter case lightly with the finger tips to help the needle overcome the slight friction which sometimes exists at the bearings and prevents an otherwise normal meter from indicating zero. If the adjustment is necessary, insert the tip of the screwdriver into the slotted screw located on the meter case directly below the meter glass, and slowly turn the adjusting screw until the pointer is at zero. View the meter face and pointer *full on* to avoid parallax. Avoid turning the screw too far, or the pointer may be bent or the spring damaged.

SECTION VI

PREVENTIVE MAINTENANCE OPERATIONS

10. MATERIALS NEEDED.

The following materials will be needed in performing preventive maintenance:

Clean cloth.
Crocus cloth.
Sandpaper #0000.
Screwdriver, small.
Screwdriver, medium.
Clean paint brush, 2-inch.
Solvent, Dry-cleaning, Federal Specification P-S-661a.

NOTE: Leaded gasoline is not recommended as a cleaning fluid for any purpose. Dry-cleaning solvent, Federal Specification P-S-661a is available as a cleaning fluid through established supply channels. Oil, Fuel, Diesel, U. S. Army Specification 2-102B may be used for cleaning purposes when dry-cleaning solvent is not at hand.

11. PREVENTIVE MAINTENANCE FOR SIGNAL GENERATOR TS-343/U.

a. Preparatory Steps. In order to perform preventive maintenance operations on the inside of the signal generator, the instrument must be removed from its case. This is done in the following manner:

(1) Place the instrument on the workbench with the panel side up.

(2) Remove the 12 mounting screws around the edge of the panel.

(3) Lift the front panel, to which all of the components are attached, from the case. Use care to prevent damaging any parts.

(4) To inspect the r-f unit, place the panel face down on the bench, remove the screw that holds the black r-f shield cover in place, and lift off the cover (fig. 3).

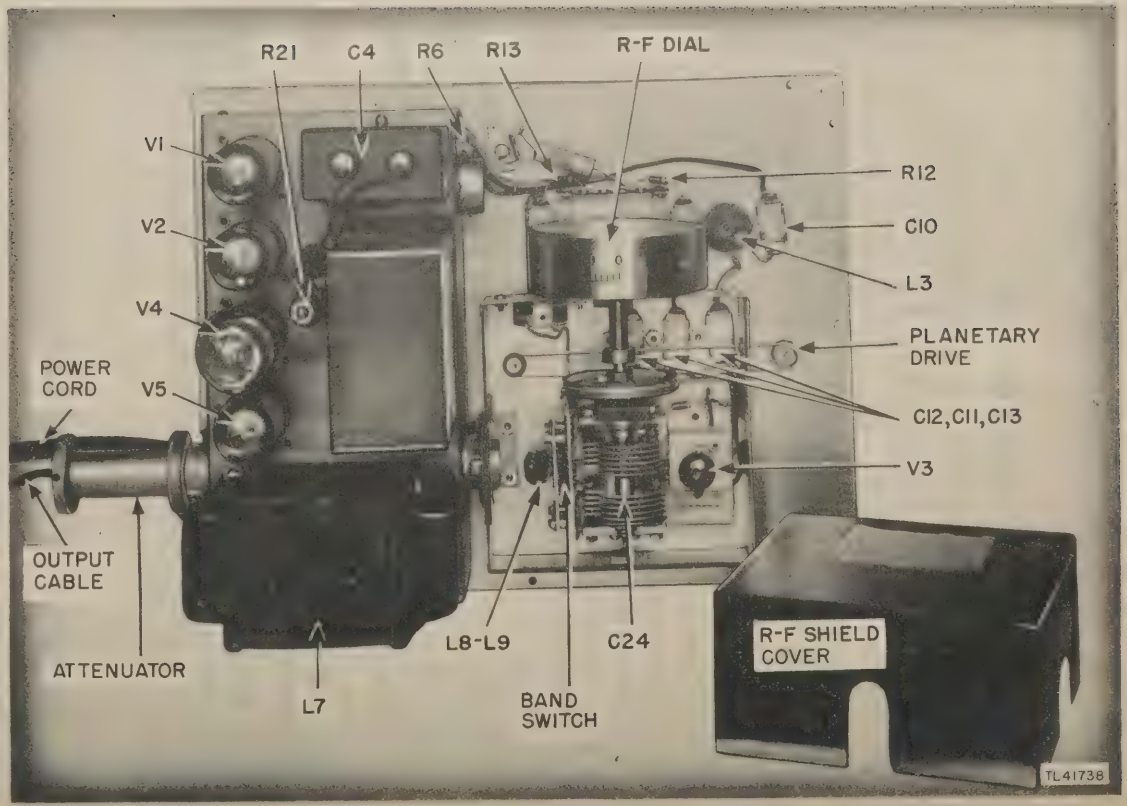

Figure 3. Signal Generator TS-343/U, rear view of panel.

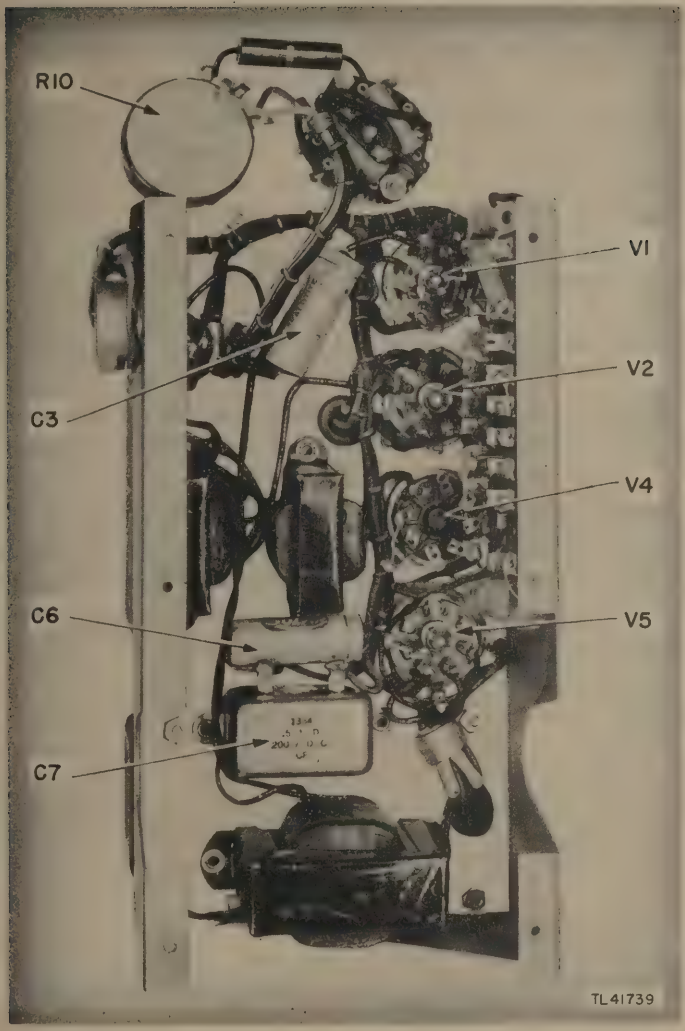

Figure 4. Signal Generator TS-343/U, bottom view.

b. Inspect. Thoroughly inspect the front and under side of the instrument panel and the case. Look for loose tubes, loose or broken connections, and loose mounting screws and terminals (figs. 3 and 4). Inspect the wiring for frayed or worn insulation. Inspect all component parts, such as tubes, capacitors, coils, and controls. Check the condition of controls and switches on the front panel.

c. Tighten. Tighten all loose mountings, connections, and terminals. Make certain that all tubes are seated firmly in their sockets. Use care when tightening the meter terminals to avoid damaging the meter case.

d. Clean. Remove all dirt, dust, and other foreign matter from the chassis and case. Thoroughly clean the meter face and the front of the panel with a cloth moistened with dry-cleaning solvent. After using the solvent, wipe the front of the panel and the meter face with a dry clean cloth.

e. Adjust. When the meter pointer requires a zero adjustment, follow the procedure outlined in paragraph 9f.

12. PREVENTIVE MAINTENANCE SCHEDULE.

The suggested time interval for performing preventive maintenance on the signal generator is monthly, but this time may be varied by the officer in charge. The operations to be performed are ITCA, which are considered first echelon repair.

SECTION VII

MOISTUREPROOFING AND FUNGIPROOFING

13. GENERAL.

Signal Corps equipment requires special attention when operated in tropical areas where temperature and humidity are extremely high. Following are some of the problems that may be encountered in operation:

a. Resistors, capacitors, coils, chokes, and transformer windings fail.

b. Electrolytic action takes place in resistors, coils, chokes, and transformer windings and cause eventual break-down.

c. Hook-up wire and cable insulation breaks down. Fungus growth accelerates deterioration.

d. Moisture forms electrical leakage paths on terminal boards and insulating strips, causing defective operation.

14. TREATMENT.

A moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection against fungus growth, insects, corrosion, salt spray, and moisture. The treatment involves the use of a moisture- and fungi-resistant varnish applied with a spray gun or brush. Refer to TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, for a detailed description of the varnish-spray method of moistureproofing and fungiproofing and the supplies and equipment required in this treatment.

CAUTION: Varnish spray may have toxic effects if inhaled. To avoid inhaling spray, use respirator if available; otherwise, fasten cheesecloth or other cloth material over nose and mouth.

15. STEP-BY-STEP INSTRUCTIONS FOR TREATING SIGNAL GENERATOR TS-343/U.

a. Preparation. Make all repairs and adjustments necessary for proper operation of the equipment.

b. Disassembly.

(1) Remove the 12 screws from the outer edge of the front panel.

(2) Remove the chassis from the case.

(3) Remove the six screws mounting the power unit to the front panel and gently lift the unit from the panel as far as the wiring will permit.

(4) Remove the knobs marked OUTPUT and MODULATION located below the meter, and remove the ½-inch nuts underneath them.

(5) Remove the four screws mounting the output meter and meter case on the front panel.

(6) Remove the case and disconnect the meter leads. Replace the nuts on the meter.

(7) Remove the nuts and washers which mount the two potentiometers on the front panel below the meter. Replace the washers and nuts.

(8) Remove the screw which mounts the circular scale and remove the scale.

(9) Clean all dirt, dust, rust, fungus, oil, and grease from the equipment to be processed.

c. Masking.

(1) Mask the following parts on the rear of the front panel:

(a) The holes in the cases of the two dismounted potentiometers (fig. 5, item A).

(b) The scale window glass (fig. 6, item A).

(c) The planetary drive (including the cord) (fig. 6, item B).

(d) The sliding surfaces on the attenuator (fig. 7, item A).

(e) The terminal jacks on the output cable (fig. 7, item B).

(2) Mask the openings on the top and sides of the r-f oscillator case, including the shaft for the circular scale (fig. 6, item C; and fig. 7, item C).

(3) Mask the following parts on the modulator chassis:

(a) The holes in the bases of the four tube sockets (fig. 8, item A).

(b) The holes in the case of the output calibration potentiometer (fig. 9, item A).

(c) The terminals on the meter leads (fig. 5, item B; and fig. 7, item D).

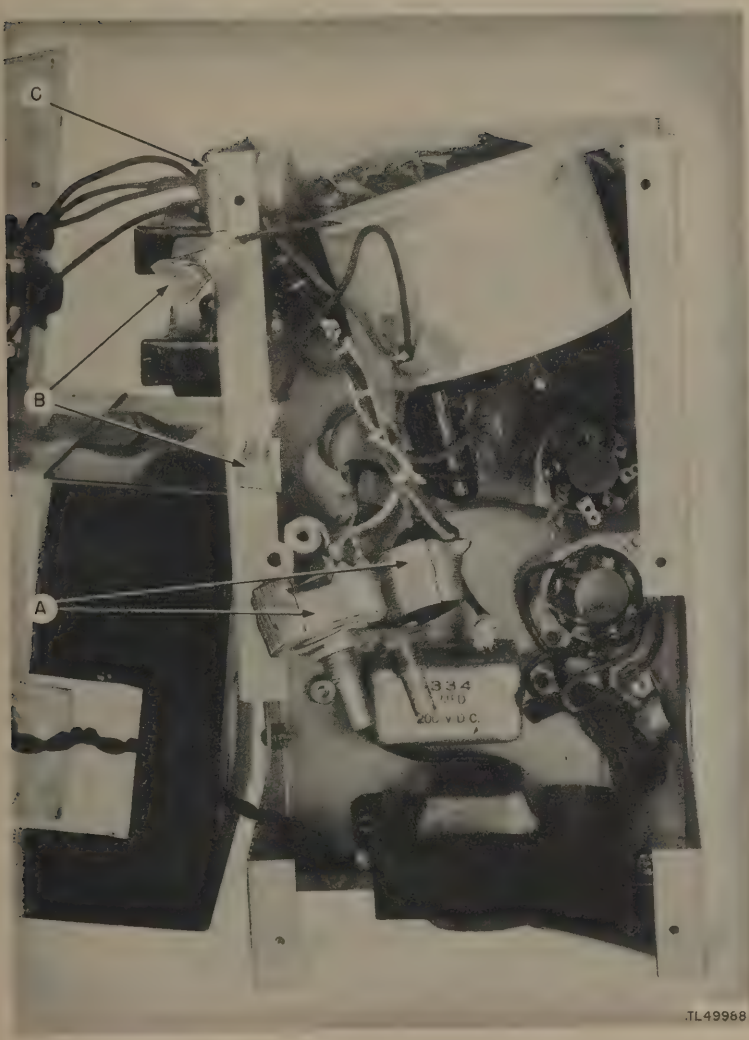

Figure 5. Chassis of modulator unit showing potentiometers removed from mounting.

(4) Mask all rubber grommets (fig. 5, item C; fig. 6, item D; fig. 7, item E; fig. 8, items B; fig. 9, item B; and fig. 10, item A).

d. Drying. Dry the unit for 6 hours at 140°F.

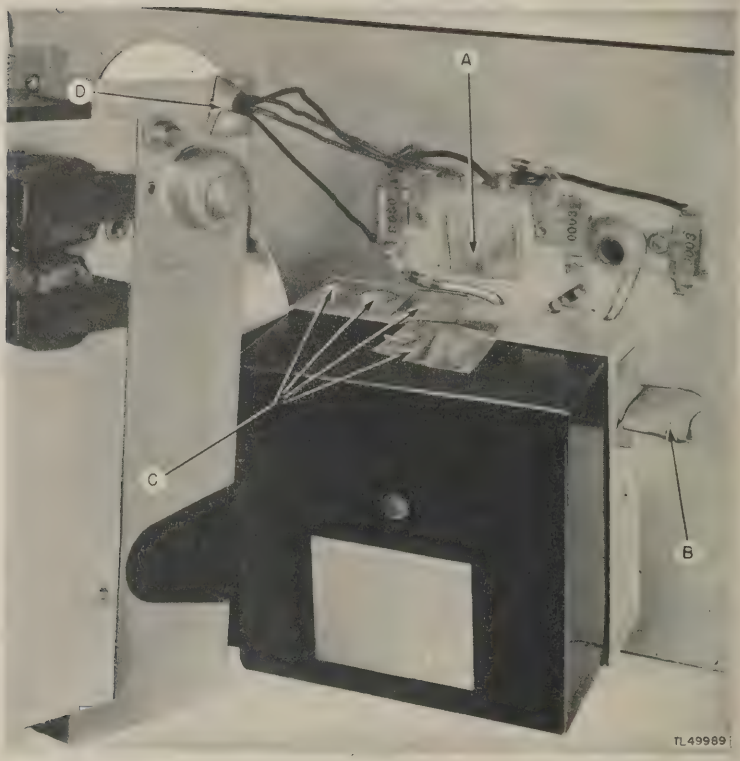

Figure 6. Rear of left portion of front panel.

Figure 7. Rear of right portion of front panel.

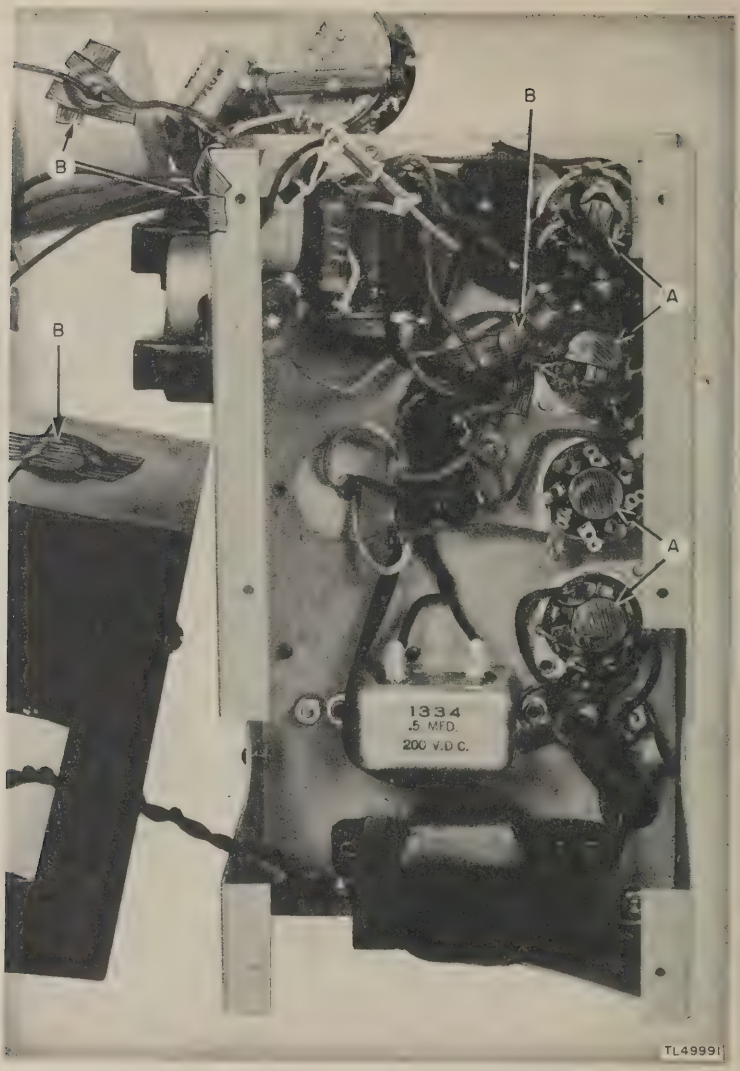

Figure 8. Chassis of modulator unit.

e. Varnishing.

(1) Apply three coats of moistureproofing and fungiproofing varnish (Lacquer, Fungus-resistant, Spec. No. 71-2202, stock No. 6G1005.3, or equal) with a spray gun or brush.

(2) Spray the chassis and the rear of the front panel.

(3) Remove the screw mounting the cover on the r-f unit, then remove the cover and brush-coat the fabric-covered wiring, the soldered connections, the phenolic parts, coils, and resistors.

CAUTION: Do not coat the contacts or plates of the variable capacitor.

(4) Brush-coat the bakelite meter case.

(5) With a brush touch up other parts, where necessary, including the planetary drive cord.

f. Reassembly.

(1) Remove all masking tape.

(2) Clean all contacts with varnish remover and burnish the contacts.

(3) Reassemble the unit and test its operation.

g. Marking. Mark the letters MFP and the date of treatment near the most conspicuous or most important nameplate on the equipment and in such a location that the marking will not become obliterated or rubbed off. In the absence of a nameplate, place the marking where it can be read easily and is not subject to wear.

EXAMPLE: MFP — 13 Jan 45.

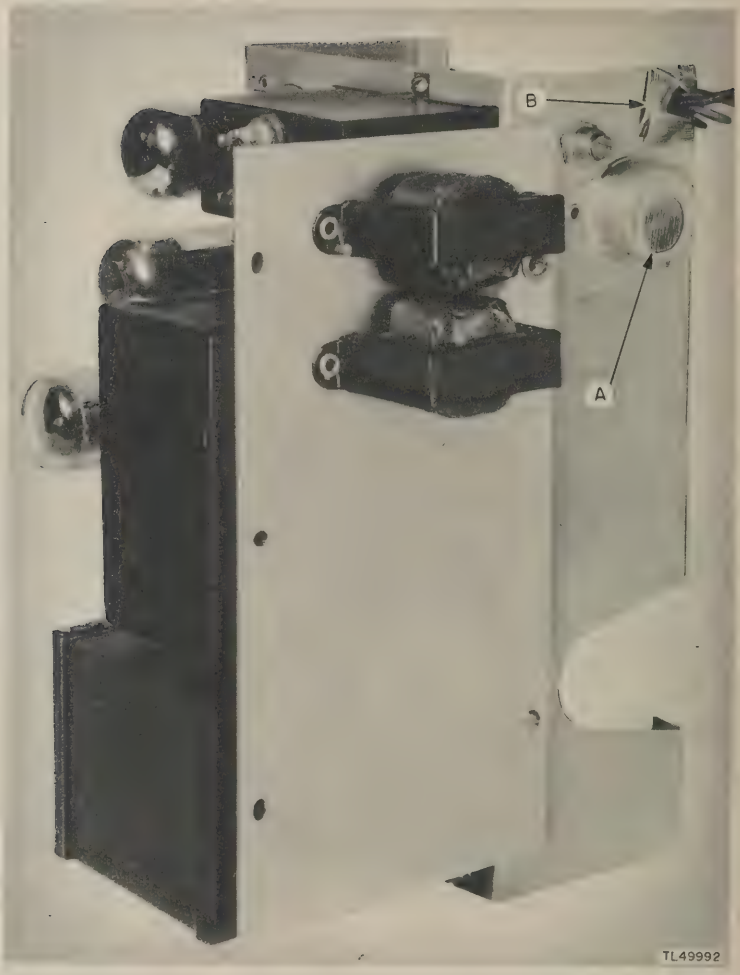

Figure 9. Front view of modulator chassis.

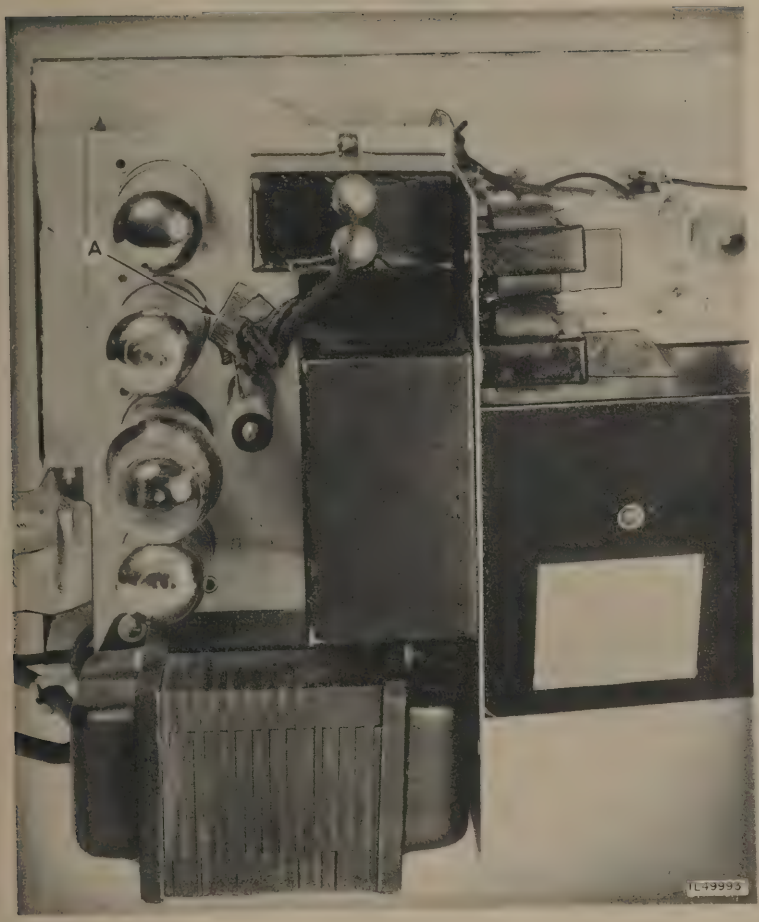

Figure 10. Top view of modulator chassis.

PART FOUR
AUXILIARY EQUIPMENT

(NOT USED)

PART FIVE

REPAIR INSTRUCTIONS

NOTE: Failure or unsatisfactory performance of equipment used by Army Ground Forces and Army Service Forces will be reported on W. D., A.G.O. Form No. 468 (Unsatisfactory Equipment Report). If Form No. 468 is not available, see TM 38-250. Failure or unsatisfactory performance of equipment used by Army Air Forces will be reported on Army Air Forces Form No. 54 (Unsatisfactory Report).

SECTION VIII

THEORY OF EQUIPMENT

16. GENERAL.

The circuit theory and characteristics of the signal generator are given in the following paragraphs. A schematic diagram of the equipment is shown in figure 11.

17. R-F OSCILLATOR.

The r-f oscillator uses a type 9002 tube operating in a Colpitts oscillator circuit. A split stator tuning capacitor, C24, simplifies tuning of the circuit. The use of moving contacts, which might cause noise as the frequency is varied, is avoided. A two-position switch selects either of the two frequency ranges by connecting into the oscillator circuit the proper inductance for the desired frequency. The connections indicated in the schematic diagram (fig. 11) are for operation in the 15- to 28-megacycle frequency range. Resister R20 is the output attenuator calibration adjustment for this frequency setting. For operation in the 27- to 50-megacycle frequency range, coil L8 is replaced by coil L9 (coil L8 is removed from the circuit), and resistor R14 is the attenuator calibration adjustment. Resistor R10, the r-f OUTPUT control, varies the plate voltage of tube V3. Attenuation of the r-f output voltage is controlled by varying the coupling between the output pick-up loop and coil L8 (or L9) in the oscillator circuit. The oscillator section is shielded by means of a silver-plated copper box. All leads into the box are carefully filtered to eliminate leak-

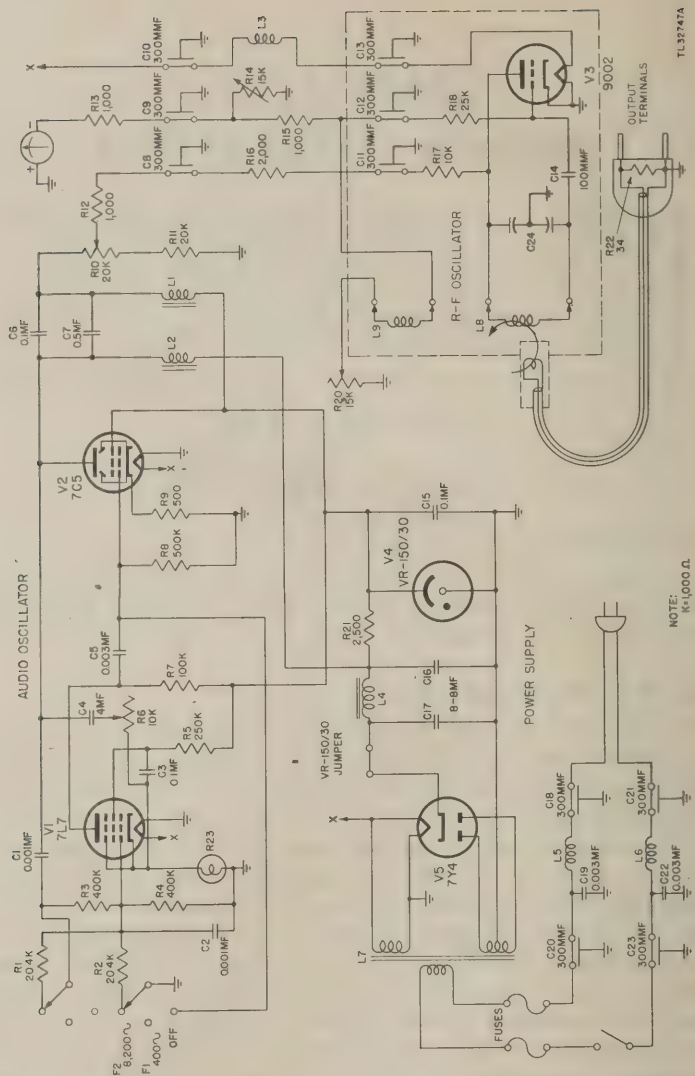

Figure 11. Signal Generator TS-343/U, schematic diagram.

age and interference from stray electromagnetic fields. The frequency scale is mounted on a drum which rotates with the tuning capacitor shaft. The tuning capacitor is driven by means of a combined planetary and cord drive which produces a reduction ratio of approximately 20:1.

18. MODULATOR.

a. Audio Oscillator. The audio oscillator used in the modulator section is of the Wien-bridge type (TM 11-466, par. 43). It operates on the resistance-tuned principle and has low distortion, stable frequency, and constant output voltage. The oscillator consists of a two-stage resistance-coupled audio amplifier, which has a portion of its output fed back to its input through a frequency-selective network in such a manner that oscillation occurs at one frequency. The amplitude of the oscillation is controlled by a degenerative network in the cathode of the first amplifier tube. This degenerative network includes a small lamp, R23, connected so that an increase in oscillation amplitude causes an increase in the resistance of the lamp filament; this increases the amount of degenerative or negative feedback, and maintains a constant amplitude of oscillation. The increased resistance in the lamp filament is due to the increased current flow in the circuit, which raises the temperature of the lamp filament and thereby increases the resistance. In most oscillating circuits the nonlinearity of a vacuum tube characteristic is utilized to limit the amplitude of oscillation, and this results in some distortion. However, in the resistance-tuned oscillator the vacuum tubes are kept on linear, or Class A, portions of their characteristics, and the control of amplitude is left to the nonlinear lamp (R23) characteristic.

b. Characteristic Variation of Audio Oscillator. This resistance-tuned oscillator has a characteristic variation in output voltage of about 1 per cent after proper adjustment. This variation takes the form of a small, slow, periodic shift in audio output amplitude, because the lamp requires a small change in the oscillator output before a correction can be made, just as an automatic frequency control circuit requires a small change in frequency to effect any frequency correction. The correction is relatively slow because of the thermal lag characteristic of the regulation lamp filament. If the degenerative feedback control rheostat, R6, controlling the amplitude of the audio oscillations, is improperly set so that insufficient power is applied to the lamp, it will not operate on a high enough part of its characteristic curve, and a "bouncing effect" or severe variation in the audio output will result, par-

ticularly when the modulation is turned off and on. If too much voltage is fed back to the lamp because of too much reduction of the control resistance, the power output tube will be overloaded, and distortion of the waveshape will result. A dull red glow of the lamp indicates sufficient negative feedback. Under normal conditions the 7C5 tube should be able to supply this small amount of power without distortion.

c. Peak Volts. The amplitude of the audio output has been adjusted by the manufacturer to produce 30 percent modulation. Since a VR-150/30 regulator tube is used to hold the plate supply to the constant value of 150 volts dc, the audio is adjusted to deliver 45 peak volts (32 volts rms) by means of the feedback control at the top of the modulation and power unit as viewed from the rear. Because of the large amount of negative feedback and automatic control effected by the lamp filament, the modulator will continue to deliver 45 peak volts over a wide range of power supply voltages.

d. Modulation Frequency. The modulation frequency is determined by the time constants of the regenerative resistance-capacitance network. The modulation switch adjusts the resistance to the correct value to produce frequencies of 400 and 8,200 cycle. To obtain other modulating frequencies, however, insert different values of resistance and capacitance in accordance with the following formula:

$$\text{Frequency} = \frac{1}{2\pi RC} = \frac{1}{2\pi\sqrt{R3C1R4C2}} \text{ (for the 400-}\sim\text{ position)}$$

Where:

R = value of the series and shunt resistors.

C = value of the series and shunt capacitors.

The modulation is turned off by shorting the grid of the 7C5 tube to ground.

19. ATTENUATOR.

The mutual-inductance type attenuator gives a logarithmic variation of output voltage with linear displacement of the movable tube. This attenuator consists of a grounded metallic tube with one end near the oscillator coil. A second coil is attached to the movable inner tube which can be moved linearly inside of the grounded outer tube to change the coupling and thus vary the output voltage. The system is designed so that a variation of

10:1 in output voltage is secured by a 9/16-inch linear travel of the movable inner coil and tube. The movable coil is connected to the output terminals by a transmission line which is terminated in its characteristic impedance to eliminate standing-wave errors. The output meter indicates the oscillator grid current so that a standard, fixed input to the attenuator can be maintained. As the instrument is tuned through its frequency range, it will be necessary to readjust the output meter to the red mark by means of the OUTPUT control, R10, which controls the plate voltage applied to the r-f oscillator. The range switch has a set of contacts which insert the correct shunt across the output meter so that it can be set to the same red mark on both tuning ranges. The attenuator is calibrated from 1 to 100,000 microvolts.

20. POWER SUPPLY.

a. The power supply uses a power transformer which has an unusually large core cross-section and can operate on frequencies as low as 25 cycles per second. It is possible to operate the instrument on 60 cycles or higher frequencies without any change in the power supply. The high voltage is rectified by a type 7Y4 tube and filtered to eliminate a-c ripple. No electrolytic capacitors are used in the instrument. The power supply leads have a filtering network, and the instrument has been well shielded to reduce to the minimum leakage and interference from stray electromagnetic fields.

b. A type VR-150/30 gaseous regulator tube is used to maintain constant plate voltage on the r-f oscillator tube in order that the output and frequency of the generated carrier wil be substantially independent of power supply variations.

c. One-ampere panel mounting fuses are inserted into each leg of the power line to protect the instrument against damage if it is accidentally plugged into a d-c outlet or into one having a higher a-c voltage than the rated value. It is important that these fuses be replaced with the correct value; otherwise, the instrument may be seriously damaged.

SECTION IX

REPAIRS

21. SERVICING.

Use care in the maintenance and service of this equipment. If service is interrupted and the trouble cannot be located easily, only experienced personnel equipped with adequate tools and precision test equipment should undertake trouble shooting, repair, and recalibration of this instrument. An inexperienced operator attempting to locate and repair troubles may damage the equipment to such an extent that shipment to a higher repair echelon will be necessary.

22. GENERAL REPAIR.

In ordinary maintenance and repair work care should be taken not to change the position or adjustment of the output or r-f oscillator coils. If any parts or circuit elements are removed for inspection or replacement, it is imperative that they be replaced exactly as before. Neglect of this precaution may result in a high percentage of output error, and may even set up electrical leakage fields great enough to render the instrument useless. Before attempting repairs, make every effort to obtain the proper tools for the job.

a. Identification of Leads. It is often necessary to remove other circuit elements to gain access to the defective part. To insure proper reinstallation, make a record of the connections to each removed element and also of the position of the element in the equipment.

b. Electrical Connections. When replacing leads, clip insulation as short as possible for satisfactory connection and avoid using more solder than necessary to make a connection secure. A slight amount of excess solder dropped accidentally inside the equipment may cause circuits or circuit elements to be short-circuited. Some clearances are very small, and extreme care must be used in soldering. Do not heat the lug or connection more than is absolutely necessary because of possible damage to near-by ele-

ments. When a wire is connected to a tube socket, the connecting wire should be long enough to prevent pull on the socket. Save time and trouble by making a thorough electrical check of any part that appears to be defective *before* removing it from the equipment.

CAUTION: Never change the location of parts or wiring leads. Such a change may necessitate complete recalibration of the equipment. Do not change the original length of wiring leads.

23. TROUBLE SHOOTING.

a. If no reading is obtained on the output meter, inspect the fuses, which are located on the front panel below the OUTPUT control and are easily removed by unscrewing them from their holders. Whenever a fuse blows, replace it with a standard 1-ampere, type 3AG fuse. If fuses continue to blow, check the power supply source to determine whether or not the correct type (a-c or d-c) and rated value of voltage is being supplied. If the fuses are not defective, the trouble may be due to a short circuit in the power supply, possibly in the power transformer or in the line filter. If the instrument does not operate and the correct reading cannot be obtained on the output meter, an inspection of the voltage regulator tube (VR-150/30), which is visible through the louvers on the right-hand side of the case, will disclose whether or not the power supply is functioning. The absence of a purple glow in this tube indicates a likelihood of trouble in the rectifier tube, power transformer, filter capacitors, or the line filter. If the regulator tube glows normally, but proper indication cannot be obtained on the output meter, the trouble may be in the r-f oscillator unit or its supply leads.

b. To locate and repair defects inside the signal generator, remove the instrument from its case by removing the 12 mounting screws around the edge of the panel (par. 11). To inspect the r-f unit, remove the black r-f shield cover. After the cover is removed, the various supply voltages to the oscillator can be checked and the type 9002 tube can be removed and tested. It may be well to insert a new 9002 tube, since some tube tests will not adequately indicate the usefulness of the tube as a high-frequency oscillator. This tube should have a mutual conductance of at least 1,800 micromhos as measured on a dynamic mutual conductance tester. The voltage on the oscillator varies with the frequency range selected and also with the setting of the OUTPUT control.

c. If the trouble is localized to the power unit, remove this unit from the front panel in the following manner:

(1) Unsolder the wires leading from the terminal strip located just above the drum dial.

(2) Unsolder the twisted red and black leads from the power line bypass capacitors located on the front panel directly under the power transformer.

(3) Remove the OUTPUT and MODULATION knobs on the front of the panel and remove the ½-inch nuts underneath them.

(4) Remove the six screws that hold the power unit in place and lift the entire unit from the front panel. Make sure that only the correct screws are removed when doing this, for loosening the wrong screws may cause trouble.

(5) After the trouble has been located and the repair effected, reassemble the instrument by reversing the order of the operations above. Do not disturb the adjustment of the three variable rheostats unless recalibration is necessary.

24. RECALIBRATION PROCEDURES.

The following procedures are to be followed when recalibration of the percentage of modulation or attenuation output is required.

a. Percent Modulation Recalibration Procedure. The rheostat marked AUDIO OSCILLATOR (R6, fig. 3) controls the percentage of modulation. To adjust the modulation percentage proceed as follows:

(1) Connect a vacuum-tube voltmeter (arranged to block d-c voltage) to the oscillator B+ lead and ground.

(2) Set the MODULATION switch to either the 400 or the 8,200 position.

(3) Turn the OUTPUT control to the maximum position.

(4) Turn the AUDIO OSCILLATOR rheostat until a peak reading of 45 volts (32 volts rms) of audio voltage is indicated on the vacuum-tube voltmeter. Since the VR-150/30 tube holds the applied plate voltage constant at 150 volts, the carrier will be modulated 30 percent by the 45 peak volts of modulation; this voltage being 30 percent of 150 volts.

b. Attenuator Output Recalibration Procedure. The relative calibration of the mutual-inductance attenuator is fixed, but the absolute reference level of 100,000 microvolts (or 0.1 volt) can be adjusted as follows:

(1) With the MODULATION control in the OFF position,

connect a sensitive vacuum-tube voltmeter across the output terminals. This vacuum-tube voltmeter must have low input capacity and very short leads to produce a self-resonant frequency well above 100 megacycles.

(2) Set the range switch to the 27- to 50-megacycle range and adjust the attenuator to read 100,000 microvolts.

(3) Set the OUTPUT control to approximately three-fourths of its full clockwise rotation.

(4) With the frequency dial set at about 40 megacycles, adjust the rheostat marked OUTPUT METER CALIBRATION, located on the side of the power unit chassis, until the output meter reads on the red mark.

(5) Loosen the setscrew in the hole in the knurled knob on the attenuator slider and adjust the position of the output pick-up coil until the vacuum-tube voltmeter reads 0.1 volts. This can be done by moving the ¼-inch chrome-plated tube which projects from the attenuator slider. When properly adjusted, the output coil should be about 1/16 to ⅛ inch from the high-frequency oscillator coil and should be oriented in the same direction as the oscillator coil for maximum pick-up.

(6) Tighten the setscrew securely in the knurled knob.

(7) Set the range switch to the low-frequency range and adjust the frequency dial to 20 megacycles.

(8) With the attenuator still adjusted to read 100,000 microvolts, adjust the OUTPUT control until the vacuum-tube voltmeter reads 0.1 volt.

(9) Adjust the rheostat inside the r-f oscillator shield can until the output meter reads on the red mark. This rheostat is accessible from the top of the r-f oscillator, just to the right of the frequency scale drum.

CAUTION: The adjustment outlined above is critical and should not be attempted unless it is absolutely necessary. Exercise care during maintenance and repair work not to change the position or adjustment of the output or r-f oscillator coils.

APPENDIX

MAINTENANCE PARTS LIST

25. MAINTENANCE PARTS LIST FOR SIGNAL GENERATOR TS-343/U.

Major component	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*	*Mfr's part and code No.*
	C1, C2	3D9980-4	CAPACITOR: 0.00098 mf ±1%; 400v; Erie type J.	
	C3	3DA100-109.2	CAPACITOR: 0.1 mf ±10%; 200v; Solar type S.	
	C4	3DB4-193	CAPACITOR: 4 mf; Fast Spec. No. 78-K1.	
	C5, C19, C22	3DA3-5.1	CAPACITOR: 0.003 mf ± 10%; 500 vdcw; Micamold type W or Dubilier 1WS.	
	C6, C15	3DA100-49	CAPACITOR: 0.1 mf ±10%; 400v; Solar type S or Mallory TP-428.	
	C7	3DA500-231	CAPACITOR: 0.5 mf ±10%; 200v; Fast type 1334.	
	C8, C13, C18, C20, C21, C23	3D9300-10	CAPACITOR: 0.0003 mf ±20%; 300 vdcw; Cornell Dubilier type 742.	
	C14	3K2010121	CAPACITOR: 0.0001 mf ±10%; 500 vdcw; Micamold type ASA CM20B101K.	
	C16, C17	3DB8-157	CAPACITOR: 8-8 mf; Fast Spec. No. 78-K2.	
	C24	3D9050V-96	CAPACITOR: tuning; National STD-50.	
	L1	3C344-20	CHOKE, modulation: 25 hy at 20 ma, 212 ohms DC resistance at 20° C (±10%); 3,870 turns of #31 wire in 36 layers; coil 1-1/32" x 1-19/32" x 1-15/32" over-all, insulated w/0.001 Kraft between layers and 2 wraps of 0.015" red rope; break-down 1,000v RMS at 60 cps; core area 1" x 1¼"; lamination EI-12 of #24 dynamo grade steel annealed after standing;	

25. MAINTENANCE PARTS LIST FOR SIGNAL GENERATOR TS-343/U (contd).

Major component	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*	*Mfr's part and code No.*
			stacked butt joint; 2 vert side covers w/two 10″ leads from one cover; case 3-1/32″ x 2-19/32″ x 3″ w/1-⅞″ x 2¼″ center mtg holes; finish black enamel or cadmium pl; Magnetic Windings Co #108KB or Stancor #C-1706.	
	L2	3C344-20	CHOKE, modulation: 10 hy min ind at 60 cps w/100 ma DC 212 ohms DC resistance at 20° C (±10%); 3,870 turns of #31 wire in 36 layers; coil 1-1/32″ x 1-1/32″ x 1-15/32″ over-all, insulated w/0.001 Kraft between layers and 2 wraps of 0.015″ red rope; insulation break-down test 1,000v RMS at 60 cps; core area 1″ x 1¼″; lamination EI-12 of #24 dynamo grade steel annealed after standing; stacked butt joint; 2 vert side covers w/two 10″ leads from one cover; case 3-1/32″ x 2-19/32″ x 3″ w/1⅞″ x 2¼″ center mtg holes; finish black enamel or cadmium pl; Magnetic Windings Co. #108KA or Stancor #C-1706.	
	L3, L5, L6	3C323-138A	CHOKE, RF: consisting of 9 turns of #20 DC wire on ⅜″ ID x 7/16″ OD; wax-impregnated paper tube ⅝″ lg; spiral wound; Measurements Corp dwg No. C-8-C.	
	L4	3C316-68	CHOKE, filter: 4.8 hy min ind at 3 v; 60 cps w/80 ma DC; 138 ohms DC resistance at 20° C (±10%); 2,140 turns of #32 enameled wire on core 25/32″ x 1-1/32″; 1-1/32″ lg; 2 wraps 0.015″ red rope w/0.0015″ glassine paper between turns; insulation break-down test 1,500v RMS core to winding; stack 1″ EI-75 of #24 ga dynamo steel annealed after standing, butt joint; vert channel 2¼″ x 1-15/16″ x 2″, base 2⅞″ over-all w/mtg holes 2⅜″ c to c; 6″ black leads from coil; finish black enamel or cadmium pl; Thordarson #T13C28 or Magnetic Windings Co. #D-77-13R.	

25. MAINTENANCE PARTS LIST FOR SIGNAL GENERATOR TS-343/U (contd).

Major component	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*	*Mfr's part and code No.*
	L7	2Z9619-114	TRANSFORMER, power: pri: 117v, 25-60 cps; 285 turns of #20 wire; 1.65 ohms DC resistance 0.005" Kraft insulation; secd #1: 400-0-400v RMS; 200 ma; 2,050 turns of #28 wire tapped at 1,025 turns; insulated w/2 wraps of 0.001" glassine paper; 98 ohms DC resistance; insulation breakdown 1,500v RMS; secd #2: 5.0v 4 amp, 13 turns of #16 wire; no insulation, 0.0469 ohms DC resistance; secd # 3: 6.3v 5.14 amp; 16 turns of #14 wire CT at 8 turns, 0.0342 ohms DC resistance; insulation, 2 wraps of 0.005 Amnite or equivalent; core 1-17/32" x 1-7/16" lg 2-1/32" tube; 2 wraps of 0.015" red rope; area of lamination 1-½"; stack EI-13 of #28 ga transf A steel annealed after standing 2" square; core loss, 5w max; max excitation current 0.3 amps; mtg holes 3" x 3¾" x 4"; finish black enamel or cadmium pl; Magnetic Windings Co. type 454K #77-14, 78-A15.	
	L8	3C323-138C	COIL, RF: E 19½ turns #34 wire spaced one thickness apart on wax-impregnated paper tube ⅜" ID x 7/16" OD x ⅝" lg; Measurements Corp 78-R15-E part 3.	
	L9	3C323-138B	COIL, RF: 4 turns of #18 E wire spaced one thickness apart on wax-impregnated paper tube ⅜" ID x 5/17" OD x ⅝" lg; Measurements Corp 78-17-A.	
	R1, R2	3Z6620D4	RESISTOR: 20,400 ohms ±2%; ½w; Concarbon type X1.	
	R3, R4	3Z6740-12	RESISTOR: 400,000 ohms ±2%; ½w; Concarbon type X1.	
	R5	3Z6725-17	RESISTOR: 250,000 ohms ±10%; IRC BT½; Speer SI½.	
	R6, R14, R20	3Z7410-26	RHEOSTAT: 10,000 ohms; 1w; Wirt type 804 and 802.	

25. MAINTENANCE PARTS LIST FOR SIGNAL GENERATOR TS-343/U (contd).

Major component	*Ref symbol*	*Signal Corps stock No.*	*Name of part and description*	*Mfr's part and code No.*
	R7	3RC21BE104K	RESISTOR: 100,000 ohms ±10%; ½w; IRC BT½; Speer SI½.	
	R8	3Z4533	RESISTOR: 500,000 ohms ±10%; ½w; IRC BT½; Speer SI½.	
	R9	3Z4524	RESISTOR: 500 ohms ±10%; ½w; IRC BT½.	
	R10	3Z7420-11	POTENTIOMETER: 20,000 ohms; 4w; WW; Clarostat.	
	R11	3Z6620-93	RESISTOR: 20,000 ohms ±10%; 2W; Centralab type 316; Speer SI-2.	
	R12, R13, R15, R19	3RC21BE102K	RESISTOR: 1,000 ohms ±10%; ½w; IRC BT½; Speer SI½.	
	R16	3Z4526	RESISTOR: 2,000 ohms ±10%; ½w; IRC BT½; Speer SI½.	
	R17	3RC21BE103K	RESISTOR: 10,000 ohms ±10%; ½w; IRC BT½; Speer SI½.	
	R18	3Z4557	RESISTOR: 25,000 ohms ±10%; ½w; IRC BT½; Speer SI½.	
	R21	3Z6250-109	RESISTOR: 2,500 ohms ±10%; 20w; Hard-Hindle type 2A15.	
	R22, R24	3Z6003D4-7	RESISTOR: 34 ohms ±2%; 1w; Speer SN½.	
	R23	6Z6820-3	LAMP: 3w, 110v; GE.	
	V1	2J7L7	TUBE: 7L7; Sylvania Prod.	
	V2	2J7C5	TUBE: 7C5; Sylvania Prod.	
	V3	2J9002	TUBE: 9002; Sylvania Prod.	
	V4	2JOD3/VR150	TUBE: VR150; Sylvania Prod.	
	V5	2J7Y4	TUBE: 7Y4; Sylvania Prod.	

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